Biodegradation of Emu Feather Fiber Reinforced Epoxy Composites

V. Chandra Sekhar
Asso. Prof., Dept.of Mechanical Engineering,
RGMCET, Nandyal, Kurnool district,
Andhra Pradesh, India

Dr. V. Pandurangadu
Professor, Dept. of Mechanical Engineering,
JNT University,
Anantapur, Andhra Pradesh, India.

Dr. T. Subba Rao
Professor, Dept. of physics,
Sri Krishna devaraya University.
Anantapur, Andhra Pradesh, India.

***Abstract*— A composite is usually made up of at least two materials out of which one is binding material called as matrix and other is a reinforcement material known as fiber. For the past ten years research is going on to explore possible composites with natural fiber like plant fibers and animal fibers. The important characteristics of composites are their strength, hardness light in weight. In the present work, composites were prepared with epoxy (Araldite LY-556) as resin and 'emu' bird feathers as fiber have been tested for chemical resistance. The composites were prepared by varying the weight percentage (P) of 'emu' fiber ranging from 1 to 5 and length (L) of feather fibers from 1 to 5 cm. The composites thus prepared were exposed to Atmosphere and buried under Earth. Observations were plotted and studied. The results reveal that there will be weight gain for all the samples including pure epoxy after three months, when buried under Earth. Weight loss was observed for all the samples including pure epoxy when exposed to Atmosphere.**

Keywords*— *Epoxy composites, Emu bird feather fibers, biodegradability.

I. INTRODUCTION

In the recent years, extensive studies are being carried out on Epoxy- natural fiber composites. Importance is being given by most of the researchers to the natural plant fibers like jute, bamboo, wood, sisal, coir, cotton and wheat straw etc. Studies are getting increased on usage of animal feathers as fibers in composites. The animal feathers are waste material and their disposal is also not an easy task without causing environmental pollution. Among the plant fibers bamboo fiber epoxy composites have better properties [1]. The chemical resistance of Geopolymer composites was studied by Xiem NGUYENTHANG et.al [2]. The advantages of natural fibers over traditional fibers are their strength, easy availability, light weight, high toughness low density etc., [3]. Jindal [4] produced the bamboo fiber reinforced plastic composites using araldite (CIBA CY 230) resin as matrix. Lot of work was done on the composites made with chicken feather, hemp, wool, fish shells. In the present paper, an attempt is made to use the emu feathers as fibers for producing composites and the effects of soil and atmosphere on the prepared emu feather fiber epoxy composites were studied.

Microorganisms use the substance as food source in biodegradation process. It occurs by reaction between the enzymes secreted by the organism and the polymer chains or additives, which make up the compound. The degradation involves the breakage of bond reactions in the composites, so that the original shape disappears. The parameters like temperature, pressure, humidity and microorganisms present in the environment will affect the rate of degradation. The biodegradation products are not toxic or environmentally harmful [5,6].

II. MATERIALS AND METHODS

A. *Materrials*

For preparation of Composite, high performance epoxy resin LY556 and the curing agent HY951 is used as matrix. Waste emu bird feathers were collected from local farms to use them as fibers in the composites. Fibers of same diameter are segregated and fibers were soaked in 5% of sodium hydroxide (NaOH) solution for 30 minutes. Then, the feathers were washed with soap water and finally with distilled water to remove the impurities and finally dried under the sunrays. The cleaned fibers were cut in to small pieces of length varying from 1 cm to 5 cm for using in the composite.

B. *Preparation of Composite specimens*

For making the composites, a mould of 150 mm x 150 mm x 5 mm was prepared with glass. The mould cavity was coated with a thin layer of aqueous solution of Poly Vinyl Alcohol (PVA) which acts as a good releasing agent [1]. Further, a thin coating of hard wax is laid over it. A 5 mm thick plate was made from the epoxy and hardener taken in the ratio of 100 and 10 parts by weight respectively. Then the molding box was loaded with the matrix mixture and emu feather fiber in random orientation (with varying percentage) and was placed in vacuum oven which was maintained at 70^0C for about 3 hours to complete the curing. After curing, the plate was removed from the molding box with simple tapering.

III. EFFECT OF ATMOSPHERE AND SOIL ON COMPOSITES

The effect of atmosphere and soil on the composites was studied. For the above purpose, the composite specimens were exposed to atmosphere at three different locations ie., Anantapur, Nandyal and Hyderabad. Similarly, the specimens were buried under earth at the above three locations. In each case, three pre weighed samples were exposed to atmosphere as well as three pre weighed samples were buried under earth for 3 months. At the end of every month, the specimens were cleaned thoroughly with distilled water and dried by pressing them on both sides by filter papers. The final weight of the samples and % weight loss or gain was determined.

IV. RESULTS

The experiments were conducted for various fiber loadings and fiber lengths. The effect of atmosphere and soil on the emu feather fiber reinforced epoxy was shown in the following graphs. The degradation process of poultry feathers was studied in detail by Vijay Kumar et al. [7].

A. *Effect of Atmosphere*

The effects of atmosphere observed were plotted and shown in the following graphs.

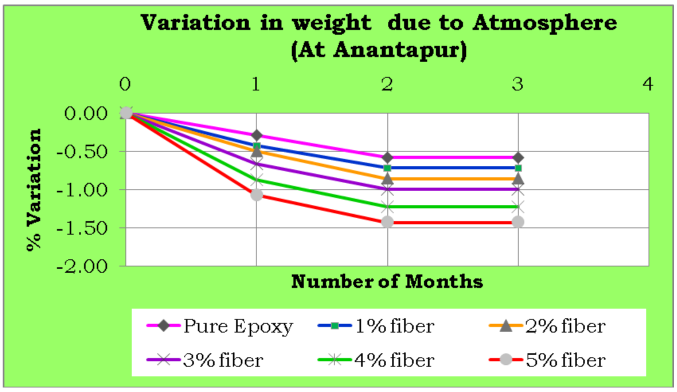

Fig 1. Variation in weight on exposure to atmosphere at Anantapur

Fig. 1 and 2 shows the % variation of weight and thickness when the emu feather fiber reinforced epoxy composites were exposed to atmosphere at Anantapur. Approximately 1.07%wt. loss noticed for 5 % fiber loading composites after one month. And it is increased to 1.43 % after second month and there afterwards no change was observed. Nearly 0.29% of wt. loss was observed for epoxy after one month and it is reaches to 0.58% after second month. After second month onwards no change was noticed.

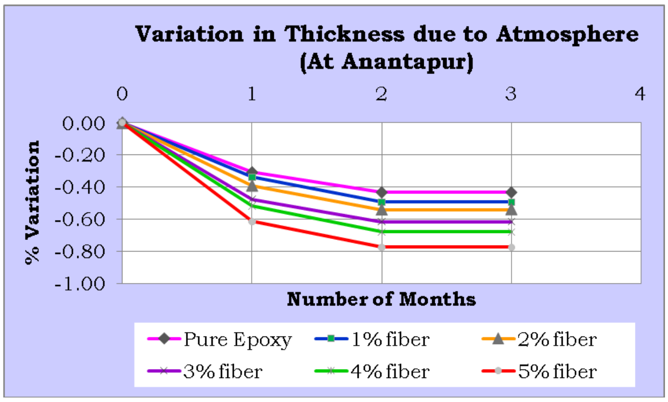

Fig 2. Variation in thickness on exposure to atmosphere at Anantapur

Approximately 0.61% loss in thickness was noticed for 5 % fiber loading composites after one month. And it is increased to 0.77 % after the second month and there afterwards no change was observed. Nearly 0.31% of thickness loss was observed for epoxy after one month and it is reaches to 0.43% after the second month. After second month onwards no change was noticed.

Fig. 3 and 4 shows the % variation of weight and thickness when the emu feather fiber reinforced epoxy composites were exposed to atmosphere at Hyderabad. Approximately 0.82%wt. loss noticed for 5 % fiber loading composites after one month. And it is increased to 1.36% after second month and there afterwards no change was observed. Nearly 0.48% of wt. loss was observed for epoxy after one month and it is reaches to 0.85% after second month. After second month onwards no change was noticed.

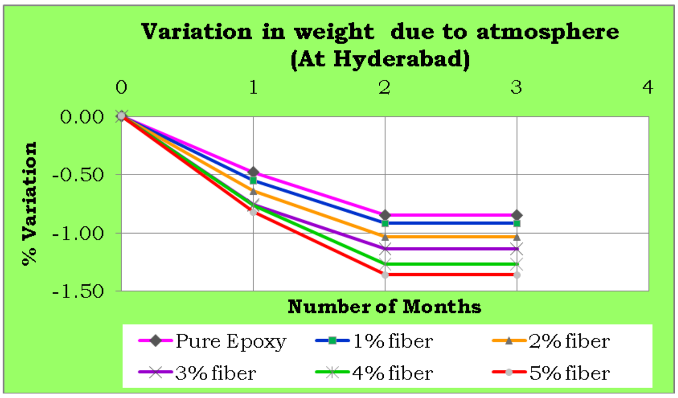

Fig 3. Variation in weight on exposure to atmosphere at Hyderabad

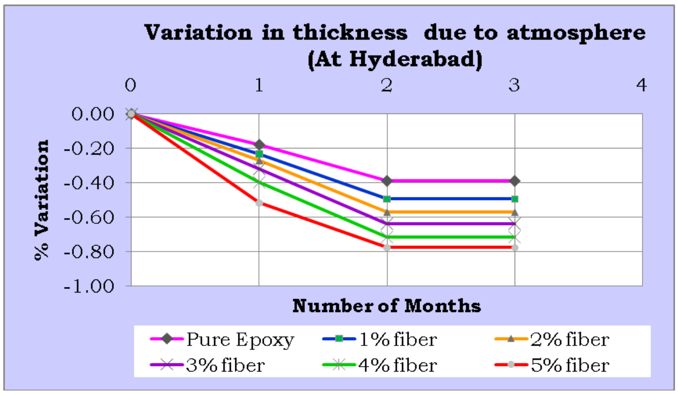

Fig 4. Variation in thickness on exposure to atmosphere at Hyderabad

Approximately 0.52% loss in thickness was noticed for 5 % fiber loading composites after one month. And it is increased to 0.78 % after the second month and there afterwards no change was observed. Nearly 0.18% of thickness loss was observed for epoxy after one month and it is reaches to 0.39% after the second month. After second month onwards no change was noticed.

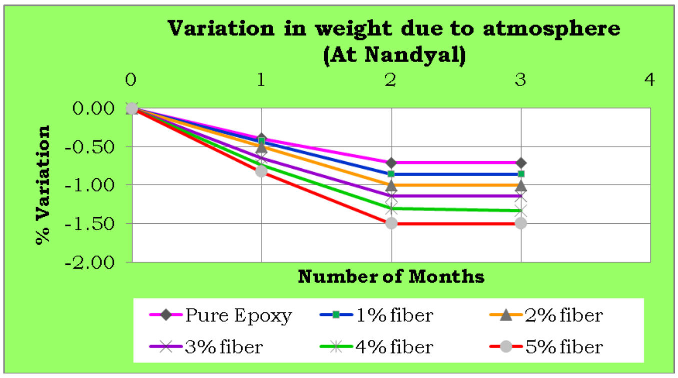

Fig 5. Variation in weight on exposure to atmosphere at Nandyal

Fig. 5 and 6 shows the % variation of weight and thickness when the emu feather fiber reinforced epoxy composites were exposed to atmosphere at Nandyal. Approximately 0.82%wt. loss noticed for 5 % fiber loading composites after one month. And it is increased to 1.50 % after second month and there afterwards no change was observed. Nearly 0.39% of wt. loss was observed for epoxy after one month and it is reaches to 0.71% after second month. After second month onwards no change was noticed been observed for pure epoxy on exposure to atmosphere at Nandyal for three months.

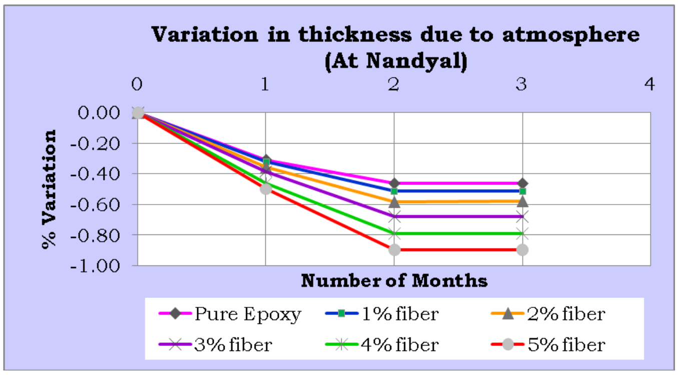

Fig 6. Variation in thickness on exposure to atmosphere at Nandyal

Approximately 0.50% loss in thickness was noticed for 5 % fiber loading composites after one month. And it is increased to 0.9 % after the second month and there afterwards no change was observed. Nearly 0.31% of thickness loss was observed for epoxy after one month and it is reaches to 0.46% after the second month. After second month onwards no change was noticed.

B. Effect of Soil

The variation in weight and thickness of the composites due to the moisture, bacteria, algae, and fungi present in the soil were shown in the following graphs.

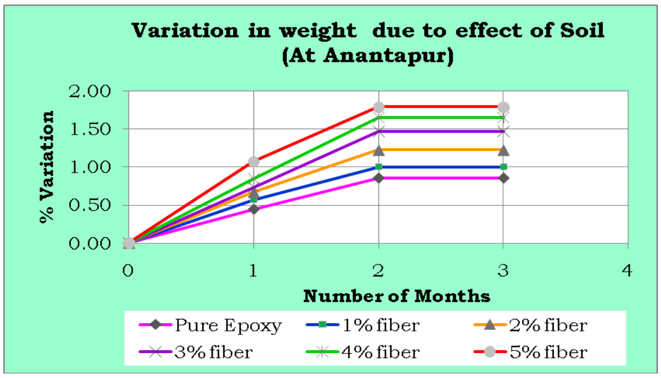

Fig 7. Variation in weight due to Biodegradability under earth at Anantapur

Fig. 7 and 8 shows the % variation of weight and thickness when the emu feather fiber reinforced epoxy composites were buried in soil at a depth of 30 cm. at Anantapur. Nearly 0.43% of wt. loss was observed for epoxy composites after one month and it is reaches to 0.86% at the end of second month. After second month onwards no change was noticed. Approximately 1.17%wt. loss noticed for 5 % fiber loading composites after one month. And it is increased to 1.72 % after second month and there afterwards no change was observed.

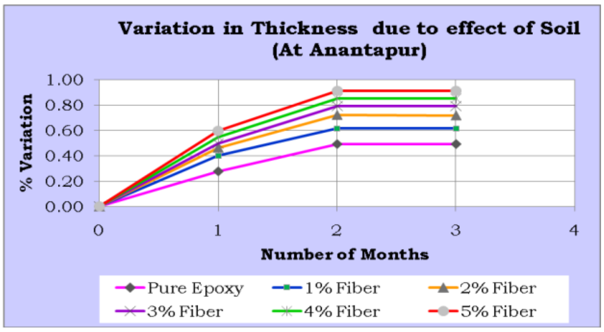

Fig 8. Variation in thickness due to biodegradability under earth at Anantapur

Nearly 0.27% of thickness loss was observed for epoxy after one month and it is reaches to 0.49% after the second month. After second month onwards no change was observed. Approximately 0.59% loss in thickness was noticed for 5 % fiber loading composites after one month. And it is increased to 0.91 % after the second month and there afterwards no change was observed.

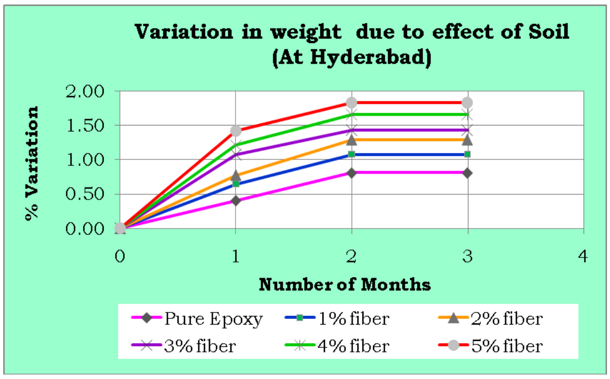

Fig 9. Variation in weight due to biodegradability under earth at Hyderabad

Fig. 9 and 10 shows the % variation of weight and thickness when the emu feather fiber reinforced epoxy composites were buried in soil at a depth of 30 cm. at Hyderabad. Nearly 0.40% of wt. loss was observed for epoxy composites after one month and it is reaches to 0.81% at the end of second month. After second month onwards no change was noticed. Approximately 1.41%wt. loss noticed for 5 % fiber loading composites after one month. And it is increased to 1.83 % after second month and there afterwards no change was observed.

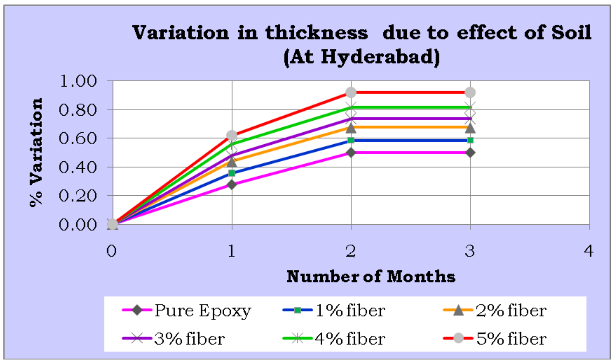

Fig 10. Variation in thickness due to biodegradability under earth at Hyderabad

Nearly 0.30% of thickness loss was observed for epoxy after one month and it is reaches to 0.51% after the second month. After second month onwards no change was observed. Approximately 0.64% loss in thickness was noticed for 5 % fiber loading composites after one month. And it is increased to 0.92 % after the second month and there afterwards no change was observed.

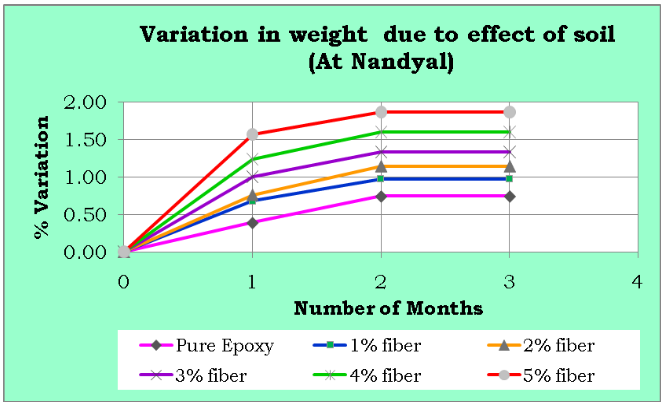

Fig 11. Variation in weight due to Biodegradability under earth at Nandyal

Fig. 11 and 12 shows the % variation of weight and thickness when the emu feather fiber reinforced epoxy composites were buried in soil at a depth of 30 cm. at Nandyal. Nearly 0.39% of wt. loss was observed for epoxy composites after one month and it is reaches to 0.74% at the end of second month. After second month onwards no change was noticed. Approximately 1.57%wt. loss noticed for 5 % fiber loading composites after one month. And it is increased to 1.87 % after second month and there afterwards no change was observed.

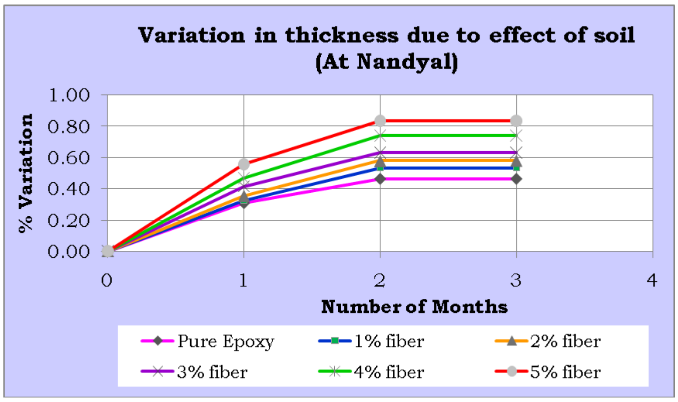

Fig 12. Variation in thickness due to biodegradability under earth at Nandyal

Nearly 0.31% of thickness loss was observed for epoxy after one month and it is reaches to 0.46% after the second month. After second month onwards no change was observed. Approximately 0.56% loss in thickness was noticed for 5 % fiber loading composites after one month. And it is increased to 0.84 % after the second month and there afterwards no change was observed.

CONCLUSIONS

In general, the effect of Atmosphere and soil on all the samples including pure epoxy is negligible.

It was observed that maximum 1.5% of weight loss was noticed when the 5% fiber loading composite samples were exposed to atmosphere at Anantapur and Nandyal. Maximum of 0.9% loss in thickness was observed for the same samples when exposed to atmosphere at Nandyal. 1.8% of wt. gain and 0.9% gain in thickness were observed for 5% fiber loading composites when buried in soil at Nandyal and Hyderabad. When the samples were buried in the soil under earth, there might be absorption of moisture by the samples and as a result, their weights might have been increased. The details of % variation in weight and thickness of all the samples of various fiber loading and fiber length due to Atmosphere and soil are given in table 1.

Table 1. Variation in weight and thickness of samples on exposure to atmosphere and soil

Sl. No.	Description	% variation in weight		% variation in thickness	
		5% fiber loading	Pure epoxy	5% fiber loading	Pure epoxy
1	Exposure to atmosphere at Anantapur	- 1.5	- 0.5	- 0.8	- 0.4
2	Exposure to atmosphere at Hyderabad	- 1.4	- 0.8	- 0.7	- 0.4
3	Exposure to atmosphere at Nandyal	- 1.5	- 0.7	- 0.9	- 0.4
4	Buried under earth at Anantapur	1.7	0.8	0.9	0.5
5	Buried under earth at Hyderabad	1.8	0.8	0.9	0.5
6	Buried under earth at Nandyal	1.8	0.7	0.85	0.45
("-ve" sign indicates decrease in weight and thickness)					

A graphical representation of the above results has been presented in figure 13.

The prepared emu feather fiber epoxy composites reacting at a faster rate during the initial stage as a result there is a change in the weight and thickness. Once the maximum values are reached the prepared composites no longer reacts with the surrounding media as a result no change was noticed in the later stages. The % variation in weight and thickness for 1% to 4% fiber loading composites was observed to be in between the range of pure epoxy and 5% fiber loading composite samples.

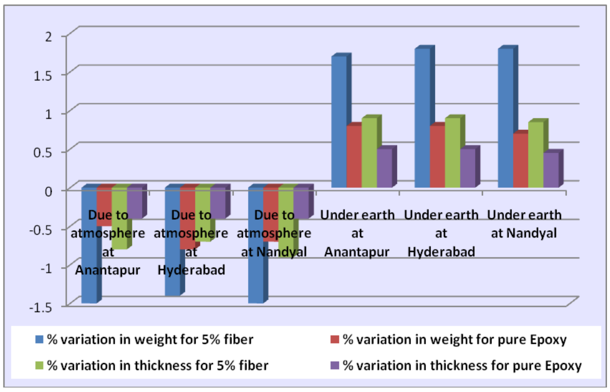

Fig 13. Graphical representation of the effect of atmosphere and soil on the emu feather fiber composite specimens.

ACKNOWLEDGMENTS

The author greatly acknowledges to G. Narender, Assoc. Prof. Dept. of Mechanical Engineering, Osmania University, Hyderabad, for his support and extended co-operation during the work. The author expresses sincere thanks to Dr. A.Varadarajulu, Professor, Dept. of Physics, Osmania University, Hyderabad.

REFERENCES

[1] Vemu Vara Prasad, Mattam Lava kumar, chemical resistance and tensile properties of bamboo and glass fibers reinforced epoxy hybrid composites-international journal of material ad bio materials applications2011:1(1):17-20

[2] Xiem NGUYEN THANG, Dora KROISOVA, Petr LOUDA, Oleg BROTNOVSKY: Moisture and chemical resistant of Geopolymer Composites,7th international conference-TEXSCI 2010

[3] A S SINGHA and VIJAY KUMAR THAKUR, Mechanical properties of natural fiber reinforced polymer composites. Bull material science,Vol 31, No.5, October 2008,pp 791-799. Indian Academy of Sciences.

[4] jindal,U.C , Development and testing of bamboo fibers reinforced plastic composites journal of composites 20:19 (1986)

[5] Bharath K.N., Swamy R.P.,Mohan kumar G.C, Experrimental studies on biodegradable and swelling charecterstics of natural fiber compositiies, IJAS,ISSN:0975-3710,Volume2, Issue 1,2010.pp-01-04 .

[6] K.N.Bharath, R.P.Swamy, A.M.Rajesh, Experimental Investigation O Biodegradable and Swelling Properties Of Natural Fibers Reinforced Urea Formaldehyde Composites, IJAEA, Volume 1, Issue 4,pp. 13-16 (2008)

[7] E.Vijaya Kumar, M.Srijana, K.Chaithanya, Y.Harish Kumar Reddy and Gopal Reddy, Biodegradation of poultry feathers by novel bacterial isolate Bacillus altitudinis GVC 11, Indian Journal of Bio technology Volume 10,October 2011,pp 502-507